Potassium Responses in California Rice Fields as Affected By Straw Management Practices

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Introduction

In an effort to improve air quality, recent legislation has forced California rice farmers to utilize a straw management practice alternative to the traditional method of burning. At this point in time farmers can either incorporate the residual straw into their soil or remove it off-site. It is much more cost effective to incorporate rice straw as there are no baling and transportation costs inherent with straw removal. However, many farmers have expressed a hesitation to incorporate rice straw as they fear their yields will be reduced as a result of weed and disease pressure. In this study, the potential benefits of rice straw incorporation were investigated in an effort to facilitate the adoption of this alternative straw management practice by California rice farmers.

The incorporation of rice straw can potentially, 1) increase the amount of plant available K in the soil, 2) improve the plant uptake efficiency of N, and 3) decrease the severity of plant diseases without deleteriously affecting grain yield. Approximately 20% of the rice in California's Sacramento Valley is produced on a K deficient soil. The average concentration of K in rice straw is around 1.5% and

the amount of straw removed by baling averages roughly 6,000 pounds per acre. Therefore, the amount of K removed in the straw from Californian rice fields can exceed 100 pounds per acre. A soil K deficiency can result when straw is removed on a continual basis. Incorporating the rice straw into the soil can reverse this loss of soil K and prevent K deficiencies on California's rice producing soils. Nonetheless, a reliable pre-fertilization soil K characterization test is critical to alert farmers when K application is required. Previous studies have shown an increase in the N uptake in rice plants when straw is incorporated rather than removed. Therefore, straw incorporation can reduce the amount of fertilizer N required for optimal grain yields. Current research indicates incorporation of rice straw increases the severity of various rice fungal diseases. However, the effect of straw management on rice diseases has not been extensively researched and requires further investigation.

Objectives

1. Re-evaluate the effect of K fertilization response of rice yield and its interaction with N.
2. Determine how adequate levels of available K affect the occurrence of rice diseases.
3. Reassess the accuracy of the soil K test on predicting plant available K.

Description

A three-year study was carried out in several rice fields throughout the Sacramento Valley of California. The majority of the field research performed for this project was located at Mathews Farms near Marysville, California. Two adjacent sites were selected, each approximately 6 acres in size. In the fall of 1998, 1999, and 2000 the straw was chopped and disked into the soil followed by flooding at one 3 ha experimental site, and was removed at the other site. Each site had a factorial experiment replicated 4 times and laid out as a split plot design with 5 rates of N as the main plot treatment and 6 rates of K as the subplot treatment. To avoid compounding years of fertilization rates, the second and third year's factorial experiments were relocated adjacent to the previous year's factorial experiment site inside the respective large 3 ha experimental site. The following agronomic values were investigated: pre-fertilization soil K content, midseason N and K tissue contents, disease severity, grain and straw yield, harvest index (mass of grain divided by whole plant mass), harvest grain and straw N content, N requirement (amount of N required to produce a total of grain), and N fertilizer use efficiency.

Results And Conclusions

This three-year study has produced evidence for a multitude of benefits resulting from the incorporation of rice straw. The incorporation of straw in a Californian rice field clearly increased plant K availability. No difference in grain yield was observed between the two straw management practices investigated in this study. However, the incorporation of straw led to increased straw yield, and because grain yield was not affected, to a lower harvest index. A K deficiency

led to an increased accumulation of N in the midseason plant and grain content when straw was removed. The K deficiency also led to decreased midseason plant K content when straw was removed. Because the increased uptake of N did not lead to a higher grain yield, a higher N requirement became evident following straw removal. Therefore, the incorporation of rice straw reduces the rates of K and N fertilizer application needed for optimal crop growth. However, the midseason plant K content did significantly increase with K application when straw was incorporated and removed. This uptake of K following K fertilization and straw incorporation indicates a possible hidden hunger for K that could manifest if this study was continued. The incorporation of rice straw did not increase the severity of aggregate sheath spot (a common rice fungal disease). There is strong evidence that rice straw incorporation can even decrease the severity of aggregate sheath spot due to the field procedure involving straw removal. In addition, the NH_4OAc test accurately predicted crop responses to various levels of K addition and AgSS severity when pre-fertilization available soil K concentrations were below 60 ppm soil. The incorporation of straw was shown to provide nutrients and/or improve soil physical properties that were beneficial to the overall grain yield but undetectable by the NH_4OAc test. It can be concluded that K fertilizer application along with straw incorporation would be preferred for long-term K sustainability of this California rice cropping system.